UNIVERSITY OF CALIFORNIA
COLLEGE OF AGRICULTURE
BERKELEY, CALIFORNIA

AGRICULTURAL EXPERIMENT STATION
E. J. WICKSON, ACTING DIRECTOR

CIRCULAR No. 16.

(NOVEMBER, 1905.)

NOTES CONCERNING SEED-WHEAT.

BY G. W. SHAW.

While farmers, grain-dealers, and especially millers, have generally lamented the occasion of such unusual havoc to the grain crop as characterized that of the past season, yet it may not be without some compensating advantages, if growers will but take the very auspicious occasion to rid themselves of undesirable seed. It is hoped that the damage to the crop of 1905 may be more than compensated by the greater attention given to the selection and adaptation of seed, so that the ultimate result will make for profit to all parties interested in cereal culture.

Many of the conditions on which success in wheat-growing depends are beyond the control of the farmer. Other conditions, particularly the variety, purity, and quality of the seed sown, are so entirely within his control that he alone must be responsible for the results dependent upon these factors.

Manifestly one of the main elements in the production of a strong seedling is a strong, sound seed. With cereal crops this is an ever-recurring question, and unfortunately is one frequently neglected by the parties most interested. Further, it is highly prejudicial to the highest results that there are numerous erroneous ideas, held very tenaciously, as to several points concerning seed-wheat. There is little doubt but that *much of the present condition of low yield is due to the lack of attention to the rational selection of first-class seed.* This fact is being constantly emphasized by the inquiries made of the Station as to the quantity of inferior seed which should be used to make up for its admitted deficiencies.

On account of the extreme conditions which obtain in most parts of the State with reference to seed-wheat, as a result of the damage from the rust attack of 1905, it is deemed best to set forth some of the facts which seem to have been quite thoroughly demonstrated with reference to the matter of seed-wheat. No apology is offered for thus presenting the work of other stations touching upon the points herein covered, inasmuch as the special cereal work inaugurated in this State by the California Experiment Station in coöperation with

the U. S. Department of Agriculture has only been in operation for a single season, a period entirely too short to yield results at all conclusive from its own experience. The circular serves but as an introduction to the work, to call the attention of farmers to certain results which have been obtained elsewhere.

In the light of the positive evidence secured by numerous investigations it may be said that it is certainly possible to add to the vitality of our wheat crop through more careful and rational attention to the seed.

Effect of Change of Seed.—There is a very widespread belief among grain-growers that there is a necessity for frequent change of seed because of actual deterioration due to continued culture under the same soil conditions. This idea is held to such an extent as to be well nigh universal. Yet, the most carefully conducted investigations, without a single exception, go to show that not only is there no benefit to be derived *from the mere change of seed*, but that actual loss occurs, *except only when there is a change to a better type of wheat, or to a more vigorous grain of the same type.* But this is not the main object usually in the mind of the grower. Farmers are continually changing seed; the one having a stiff soil must have seed from a sandy soil, and he with a sandy soil must buy seed from a heavy soil. Then again, seed is frequently brought long distances and often from regions of very different climatic conditions, with the hope that some *immediate* increase will be obtained in the yield.

Such indiscriminate change of seed is a most potent factor against proper seed improvement, and there will be little hope of improvement if one must give up a desirable strain every few years for one grown on some one else's land.

The North Dakota Experiment Station[1] conducted some extensive experiments to thoroughly test this idea, "embracing thirty-nine different samples of wheat of known history representing the varied soils of the State." These samples were grown at the Station under conditions which "make such comparative test of great certainty as to equality of condition. * * * Wheat grown for a number of years on widely varying types of soils were then planted in direct and similar soil association." It was found that standard types of wheat of the same variety brought from different soils and grown side by side at the Station, no matter how marked was the difference in the appearance of the original seed, all gave approximately the same results. "In those in which slight variation did occur it was found that other elements constituted the matter of cause. That is to say, seed grain from a special type of soil has not been found to vary in the product because of the fact that it came from a peculiar soil."

[1]Bulletin 17, North Dakota Experiment Station: H. L. Bolly.

These results were further corroborated by similar tests of injured wheats, the only apparent difference in these samples being that *the product from weak seed was very inferior in quantity.*

To further test the idea of gain from a change of soil, seed was sent from the Station to various types of land in other portions of the State.

The result of these and other experiments indicates that varieties of wheat do not degenerate *per se*, at least within any reasonable length of time, by being grown continually upon any one soil. In other words, that a given type of soil seems to produce certain well-defined characteristics in the kernel of whatever variety may be grown upon it.

That Darwin, that great observer of nature's laws, did not share in the idea of degeneracy is indicated from his statement: "I never have seen grain which has either been improved or degenerated by cultivation so as to convey the change to the succeeding crop."[1] He also cites Dalbret as having cultivated 160 kinds for a period of thirty years, all of which kept true.[2]

Results obtained at the Ohio Experiment Station further confirm this idea. Velvet Chaff and Silver Chaff have been grown continuously without change of seed for twelve years; no loss of quantity or capacity to yield is noted.[3]

[4]At the Indiana Station, Fultz, Michigan Amber, and Velvet Chaff have been grown eleven consecutive years. The average yield for the first ten years was 27.3, 29.4, and 29.8 bushels. The eleventh year (1894) the yields were 39.67, 35.66, and 27 bushels, from which Professor Latta says: "It is high time that the farmer everywhere should abandon the notion that wheat will 'run out'."

[5]The North Dakota Station, in discussing the same matter, cites results with six varieties of wheat the exact history of which was known, as follows:

	Bushels.
Average yield of wheat from seed home grown continuously (7 years)	22.67
Average yield of wheat from seed which had taken a vacation for three years: Minnesota first and second crop	18.55
Difference in favor of the old seed	4.12
Average yield of wheat from Minnesota seed grown in North Dakota one year	21.88
Average yield of wheat from seed direct from Minnesota	20.64
Difference in favor of the older seed	1.24
Average yield of wheat from Minnesota seed grown in North Dakota two years	36.59
Average yield of wheat from Minnesota seed grown in North Dakota one year	31.00
Difference in favor of the older seed	5.59

[1] Animals and Plants under Domestication. Vol. 1, p. 33.
[2] Citation from Loisleur: Des Longchamps, Considerations sur les Cereals, pp. 45–70.
[3] Bulletin 42, p. 88, Ohio Experiment Station.
[4] Bulletin 51, Indiana Experiment Station.
[5] Bulletin, North Dakota Experiment Station, p. 422.

Here is shown a case in which a change of seed was the only factor, the selection of the seed and its manner of growing having been the same.

[1]Prof. T. L. Lyon, of the Nebraska Experiment Station, in experiments continued from 1899 to 1904, comes to the following conclusion: "That a variety brought from a more humid to a drier climate will not do as well for a number of years as the same variety which has been grown in the dry climate continuously."

In the light of these carefully conducted experiments we may safely lay down the principle that *unless the change be for the purpose of obtaining a better variety or a stronger seed* there can be no advantage resulting from a change of seed-wheat, and in case seed be purchased from a portion of the country where climatic conditions are quite unlike those of California the seed is not likely to be at its best for several years.

If seed shows signs of running-out it simply means that proper care has not been taken in the selection of the seed to remove small, shriveled, and light-weight kernels, and to use only plump kernels. With proper care in the selection of seed, wheat does not deteriorate from any change within itself. But to maintain the standard of yield *care must be taken in the selection of the best seed* and to practice rational methods of rotation, manuring, and tillage to maintain the fertility of the soil.

Large vs. Small Kernels for Seed.—This is another of the mooted questions among growers, and the evidence presented below is respectfully submitted for their consideration:

The Nebraska Experiment Station presents the following results of two years' trials:

	Turkey Red Wheat. Yield per Acre: Bushels.		Big Frame Wheat. Yield per Acre: Bushels.	
	1899.	1900.	1900.	1901.
From heavy seed	29.5	29.3	25.1	27.7
From ordinary seed	27.5	26.3	25.8	25.8
From light seed	23.0	26.7	20.5	21.2

The average yield for both varieties for each year is as follows:

	1900.	1901.
From heavy seed	27.3 bu.	28.5 bu.
From ordinary seed	26.7 "	25.9 "
From light seed	21.8 "	23.9 "

[1]Bulletin 89, Nebraska Experiment Station.

Yield of Grain and Straw.

	1901.		1902		1903.		Average.	
	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.	Grain.	Straw.
LARGE HEADS.	*bu.*	*tons.*	*bu.*	*tons.*	*bu.*	*tons.*	*bu.*	*tons.*
From large grains	29.3	2.12	27.50	1.50	40.31	3.44	32.37	2.35
From small grains	22.7	1.76	23.40	1.36	39.58	3.41	28.56	2.18
MEDIUM HEADS.								
From large grains	29.3	2.04	30.41	1.63	38.33	3.65	32.68	2.44
From small grains	29.0	2.13	27.80	1.36	26.25	3.36	31.01	2.28
SMALL HEADS.								
From large grains	28.2	2.21	24.60	1.13	32.50	3.00	28.63	2.11
From small grains	26.1	2.18	20.00	.90	31.14	2.72	25.75	1.93
GENERAL SELECTION.								
From large grains	30.4	2.27	20.60	.88	34.79	2.73	28.60	1.96
From com'l sample	22.9	1.84	20.60	1.08	34.47	2.72	26.00	1.88
From small grains	24.5	1.85	14.30	.70	31.46	2.61	23.42	1.72

[1] The Tennessee Experiment Station presents the following data:

	Weight of Grains, lbs.
LARGE HEADS.	
Large grains	2418.7
Small grains	2375.0
MEDIUM HEADS.	
Large grains	2300.0
Small grains	2175.0
SMALL HEADS.	
Large grains	1850.0
Small grains	1868.7
GENERAL SELECTION.	
Large grains	2087.5
Commercial sample	2068.7
Small grains	1887.5

The results given below were obtained by Dr. N. A. Cobb, New South Wales[2], the experiments covering three years, and were far too exhaustive to consider each separately. Suffice it to say that with numerous check-plots the investigation embraced twenty-four varieties of wheat separated into large, medium, and small grains, as in the above-named experiment, and the average results obtained were as follows:

	Bushels per Acre.	
	1st year.	2d year.
From large plump grain	32.02	10.34
From medium plump grain	26.77	8.66
From small plump grain	24.86	6.50

Large and Plump vs. Small and Shriveled Seed.—For the present season the results presented under this head should have special application, since there are so many farmers, as a result of the extreme rust conditions of 1905, who have on hand nothing but badly shriveled (pinched) seed. The question is constantly being put to the Station authorities as to the value of pinched grain for seed purposes, and it is

[1] Bulletin No. 4, Vol. XVI, Tennessee Experiment Station, p. 77.

[2] Seed Wheat: Misc. Pub. No. 625, N. S. W. Department of Agriculture.

hoped that the following results secured by Dr. N. A. Cobb in New South Wales[1] in a most painstaking investigation may prove suggestive. These experiments covered five varieties, which gave the following average results, they being uniformly in favor of the plump seed:

From plump seed	20.18 bu.
From shrunken seed	18.52 "

That the germination of such seeds is fair is indicated by a test made by the writer of this circular, which showed 92 per cent of the grain actually germinated; but the plantlets were very weak and undoubtedly their vitality would always remain low.

It is not easy to give an accurate definition as to what is meant by shriveled seed, but the following illustration will serve to show the contrast between plump and shriveled seed as here discussed. Doubtless the entire discussion is due to the fact that extremely inferior-look-

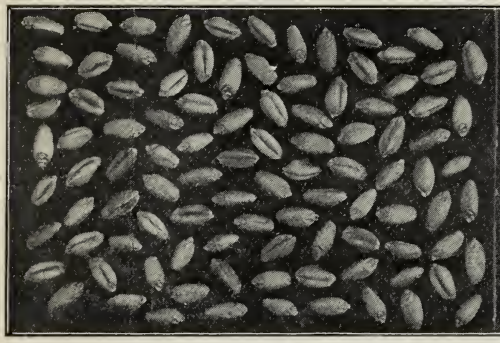

FIG. 1. A good type of seed-wheat; natural size.

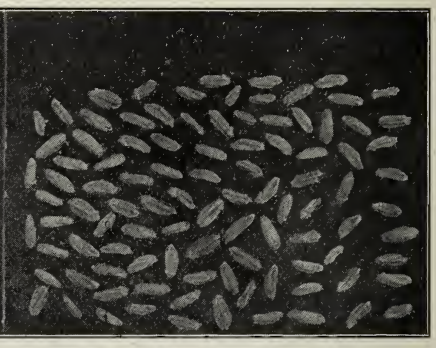

FIG. 2. A type of seed very much shrunken; natural size.

ing seed will actually germinate and to a certain extent grow and bear a crop, and *under favorable conditions* may even produce a good yield. This fact has unfortunately given rise to much carelessness in the selection of seed-wheat, which must be overcome if we are to secure the highest results in grain culture.

These results are in entire harmony with what we know as to the necessity of securing vigorous, plump seed in the case of alfalfa and other crops. The same fact is recognized by the farmer with reference to the parentage of his animals, but unfortunately the idea holds that the case is different with wheat. It is to be hoped that grain-growers will take advantage of the condition of much of the local supply of wheat to secure new seed, and start with a good type of seed-wheat.

In this connection it may be mentioned that there will be no more favorable time than this to make a trial of some of the harder winter wheats, especially that desirable bread variety known as "Turkey

[1] Seed Wheat: Misc. Pub. No. 625, N. S. W. Department of Agriculture.

Red," which gave so much promise last season when grown alongside of our more common varieties.

Prevention of Smut.—An examination of a large number of samples of California-grown wheat shows a deplorable lack of attention to the prevention of smut. Farmers doubtless do not realize the large loss which occurs from this trouble. In a number of cases the samples have shown as high as 10 per cent of smutted grains—an amount sufficient to seriously affect the profit from the crop. This is more to be deplored since the methods which can be employed are both easy of application and extremely effective.

There are three methods which can be recommended as well nigh positive in result, when the seed has been properly treated. These methods are set forth below in the order in which they are recommended.

FORMALDEHYD METHOD.

Use one pound of formaldehyd (40 per cent strength, known as formalin) to 50 gallons of water. The solution may be placed in barrels or tanks until used. The wheat may be dipped into the solution in loosely woven bags or wire baskets, allowed to remain for ten minutes, and then drained to save all the liquid possible, and dried when it is ready to sow.

If it is preferred, the seed may be spread on a clean canvas or board floor and the formaldehyd solution applied with a sprinkler, or hose and nozzle, constantly stirring and mixing the grain with a rake or shovel until all the kernels are thoroughly wetted, when it is allowed to dry.

Be sure to get 40 per cent formalin. Dealers sometimes give a 25 or 30 per cent formalin for a 40 per cent.

The formalin should be weighed in order to make sure that a full pound to each 50 gallons of water be used. The cans in which the formalin comes often contains only three fourths of a pound, hence the necessity of this precaution.

This treatment has an advantage over some others, in that it is not poisonous to persons handling the material.

BLUESTONE OR COPPER SULFATE METHOD.

This is the method practiced almost exclusively in California. Its lack of effectiveness in many cases may generally be traced to a lack of thoroughness in the work. The details of the treatment are the same as in the formalin method.

A solution is made by dissolving 1 pound of blue vitriol in 4 gallons of cold water, and dipping the wheat in the solution, as above, until the grain has become thoroughly wet, after which it is immediately dried. Or the wheat may be piled upon a floor or canvas, and thoroughly

sprinkled or sprayed with the solution while the grain is being constantly shoveled over, so that every grain becomes wet over the entire surface. Care should be taken that the solution is of uniform density by thoroughly agitating just previous to use.

HOT-WATER METHOD.

When the proper care is taken this method has proven very effective.

Utensils Required.—1st, a boiler or large kettle in which to boil water; 2d, a vessel for cold water; 3d, a vessel for water at 120°–132° F.; 4th, a vessel, barrel, or tank containing water kept constantly between 132° and 135° F.; 5th, a drying place where the grain is dried so it will pass through the drill or seeder; and 6th, an accurate thermometer to keep the temperature of the water within the above limits.

How to Proceed.—The vessels having been arranged and filled with water at the proper temperature, some convenient bulk of well-cleaned seed-wheat is taken in a loosely-woven bag and immersed in the first vessel containing water at 120°–132° F., keeping the wheat in constant agitation by moving the bag in the water, or by stirring the wheat. In about five minutes, when the seed will be well warmed and thoroughly wet, it is raised out and most of the water allowed to drain out, then immersed in the second vessel containing water at 132°–135° F., moving or stirring as before, and keeping close watch that the temperature does not fall below 132°. After twelve minutes it may be taken out and spread out to dry at some place where it will not be contaminated with fresh spores. When it is dry it may be sown. Some advise dipping in cold water at last, but that retards the drying, and should be omitted.

Cautions.—1. Keep the water in the first vessel well up to 132° in temperature, as the cold wheat will lower it rapidly.

2. Keep the temperature within the limits stated for the second vessel (which should be a large one), or the method will not give the desired results.

3. Be sure the thermometer registers correctly.

4. The seed-wheat will swell somewhat, and one third to one half more bulk of seed must be sown to remedy this result.